

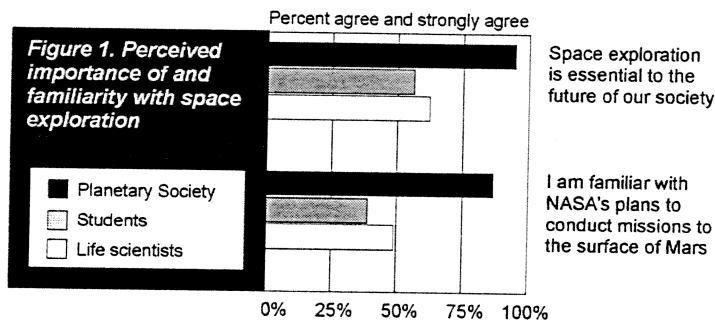
more stringent risk-management approach than would otherwise be the case based on technical considerations alone.

The design of the study compares perceptions and attitudes about space exploration relevant to a Mars sample return mission between three respondent groups: (a) members of The Planetary Society, a group representing individuals with a strong interest in space-related issues (surveyed in 1994), (b) a group of university-aged students, representing a population rela-

tively sensitive to environmental hazards (surveyed in 1995), and (c) a group of life scientists outside of the space-research community and who had a special interest in nuisance species (surveyed in 1995). Members of The Planetary Society received the survey as part of a special issue of *The Planetary Report* (July/August, 1994) on planetary protection, which contained a number of background articles on planetary protection and related topics. A synopsis of the issue was prepared as an introduction to the survey for the other two groups.

Results

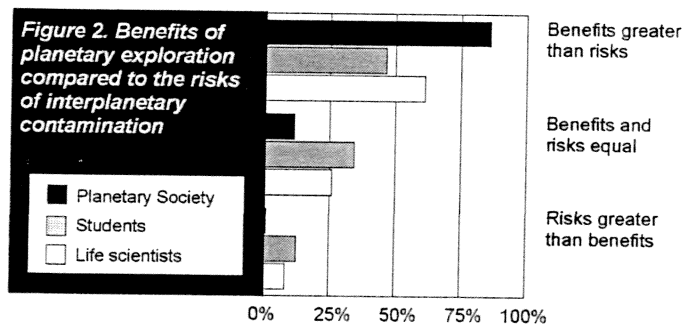
Perceived Importance of Space Exploration



The Planetary Society group generally exhibited greater agreement than did either the Student group or the Life Science group that space exploration is essential to the future of our society (see Figure 1). However, the Planetary Society group also indicated much

greater familiarity with NASA's plans for Mars exploration. Over half of Planetary Society respondents were familiar with Mars exploration plans, while less than half of the Student respondents indicated familiarity. The Life Science respondents were only slightly more familiar with Mars mission plans than were the Student respondents. The high level of familiarity of the Planetary Society group is very likely attributable to a combination of factors, including this group's inherent interest in space issues (as evidenced by their membership in The Planetary Society), and the set of articles discussing past and future Mars exploration that appeared in the special issue of *The Planetary Report* in which the survey appeared.

Perceived Benefits of Space Exploration



The Planetary Society group generally saw the benefits of planetary exploration as greater than the risks of interplanetary contamination. Only a very small percentage of the Planetary Society group saw the risks exceeding the benefits. The majority of the Life Science group also saw the benefits as greater than the risks, though not as strongly as the Planetary Society group (see Figure 2). The Student group was much more equivocal in its perceptions of benefits versus risks: less than half of the group perceived the benefits as greater than the risks, and slightly over a third saw the

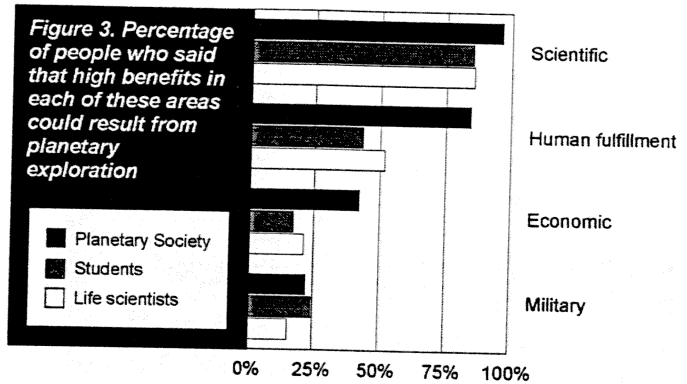
benefits and risks as equal. However, for each of the three groups surveyed, a minority of respondents perceived the risks of planetary contamination to be greater than the benefits of exploration.

A more detailed indication of benefit perceptions was obtained from a set of items relating to four different categories of benefits that could result from planetary exploration: *economic* benefits, *scientific* benefits, *military* benefits, and *human fulfillment* benefits (see Figure 3).

Respondents in all three surveyed groups tended to see high *scientific* benefits resulting from planetary exploration. Indeed, there was little difference be-

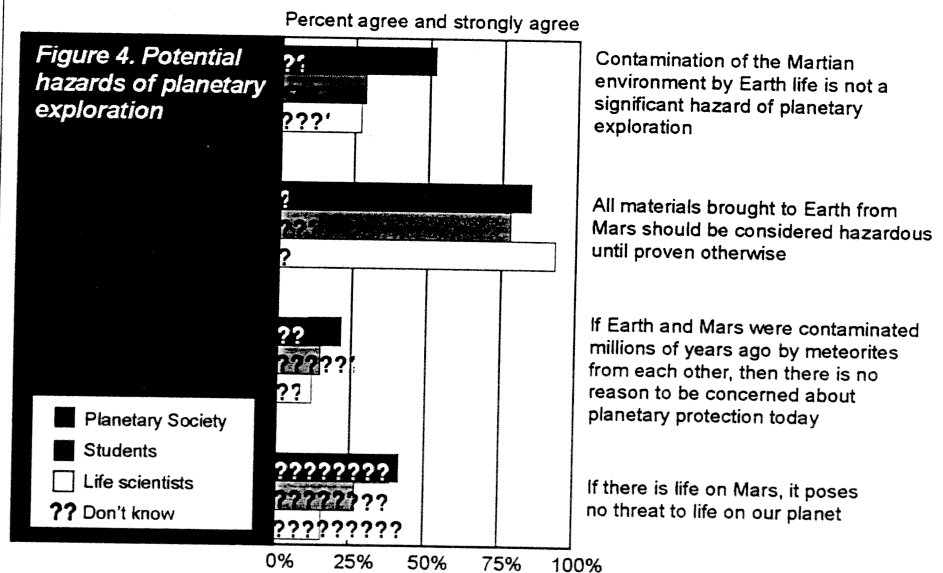
tween the three groups in terms of their perception of this category of benefits. Likewise, relatively few respondents (25% or less) in each of the three surveyed groups saw a high level of *military* benefits resulting from planetary exploration. Respondents in the Planetary Society group were more likely to see high *economic* benefits than were respondents in either the Student group or the Life Science group. The category of

benefits that most distinguished the three surveyed groups was *human fulfillment* benefits: The vast majority of the Planetary Society group saw a high level of *human fulfillment* benefits as resulting from planetary exploration. However, only half (51.8%) of the Life Science group perceived high benefits in this category, and less than half of the Student group perceived such benefits.



Perceptions of Potential Hazards of Planetary Exploration

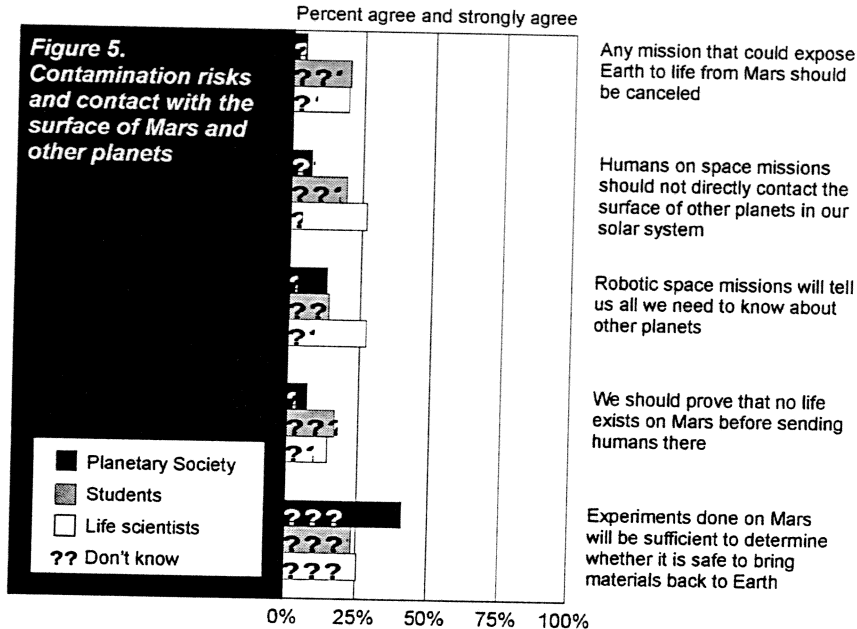
By a very high percentage, respondents in all three survey groups agreed that Mars sample return materials should be considered hazardous until proven otherwise (see Figure 4). Here, the perceived need for caution was strongest in the Life Science group. There was a high level of “don’t know” responses across all three groups regarding whether life on Mars, if it exists, poses no threat to life on Earth. However of those who did offer an opinion, a clear minority of respondents in all three groups agreed that Mars life would pose no threat. Taken together, this pattern of responses sug-



gests that, for the most part, respondents were either uncertain about the potential for Mars life to pose a hazard to Earth, or

perceived it to be a potential hazard, and believed that hazardousness should be assumed until proven otherwise.

Perceptions of Contamination Risk Management and Contact with the Martian Surface



As with items previously discussed relating to the potential risks of planetary contamination, the Planetary Society group was more likely than the other surveyed groups to disagree that Mars missions and contact with the Martian surface should be restricted or prohibited because of potential contamination risks (see Figure 5). Similarly, Planetary Society respondents were more likely to agree that experiments done on Mars will be sufficient to

determine whether it is safe to return biological materials back to Earth. These responses are consistent with earlier responses indicating the generally positive attitude that Planetary Society respondents have toward space exploration, as well as their somewhat lower level of concern about the potential hazards of biological contamination than the other groups surveyed.

Respondents in the Life Science group were more likely to agree that humans should not directly contact the surface of other planets and that robotic space missions will tell us what we need to know. While these responses suggest that there are attitudinal differences between the groups surveyed regarding the aggressiveness with which space exploration should be undertaken, the results overall do not indicate a serious reluctance on the part of any of the groups surveyed to conduct missions to other planets.

Beliefs About the Survivability of Life on Other Than Home Planet

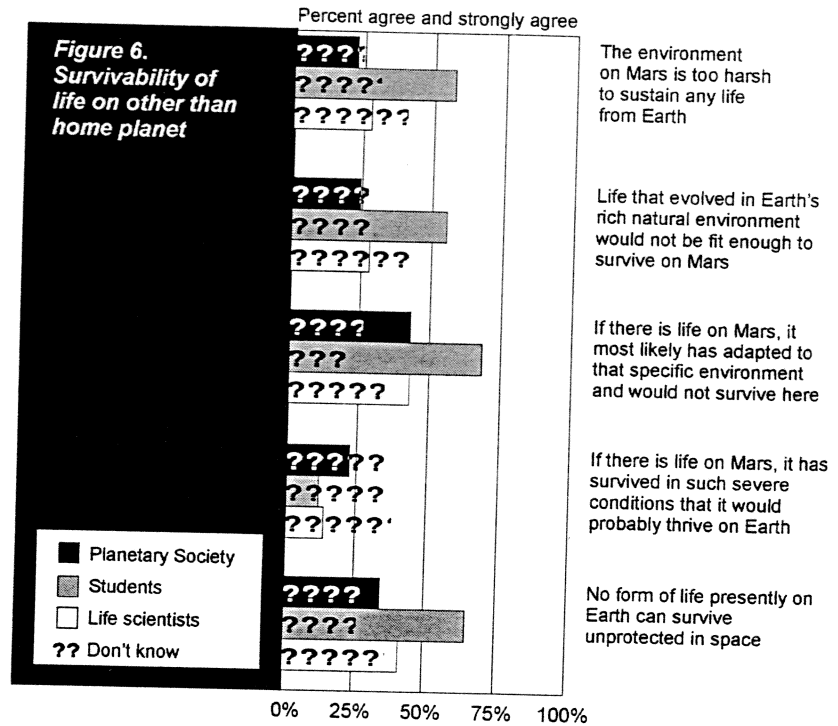
Perceptions about the potential risks of forward and backward contamination rest in part on beliefs about survivability of life on a planet other than its home planet (see Figure 6). Studies of environmental risk perception have generally suggested that laypeople hold views about the viability of nature and the endangerment of plant and animal species due to environmental change that are based on a “niche” concept, that life is fragile and adapted for survival in a relatively narrow or constrained set of environmental conditions. However, other research on perception of risk from biotechnology and genetic engineering suggest that attitudes about some biological risks are based on a “fitness” concept, that life is (readily) adaptable to new environments.

Noticeably, there is relatively high level of uncertainty among all respondents to items in this category, as evidenced by the large number of “don’t know” responses. Thus, perceptions concerning the survivability of life in an environment other than its natural one are possibly poorly formed and potentially labile.

Among those who did respond with either agreement or disagreement, the Student group stands out

from the other two groups surveyed. The majority of the Student group tended to perceive that Mars is too harsh an environment to sustain Earth life, and that Earth life is not fit enough to survive on Mars. Conversely, the majority of the Student group also tended to perceive that Mars life would not survive on Earth, and to disagree that Mars life would thrive on Earth because it has survived in such harsh conditions on Mars (53.6%). Thus, the Student group tended to hold a “niche” viewpoint: that life from either planet is fragile and not likely to survive elsewhere.

For the Planetary Society group, only weak agreement was obtained that Mars is too harsh to sustain Earth life and that Earth life is not fit enough to survive on Mars, suggesting a “fitness” model. However, for Mars life the results suggest that the Planetary Society group tended to be “niche” oriented. The responses of

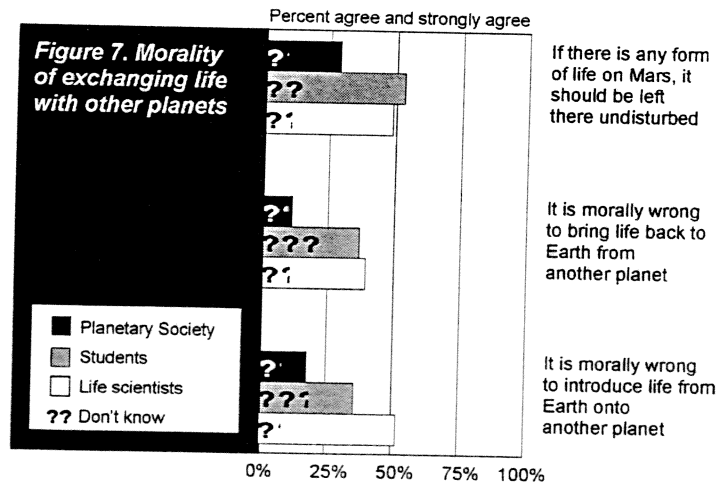


the Life Science group closely paralleled those of the Planetary Society group, with a “fitness” orientation in the direction of forward contamination (Earth life surviving on Mars), but a “niche” orientation toward back contamination.

Morality of Exchanging Life with Other Planets

Perceptions of risk and risk management, are in some cases, based in part on moral judgments about what is fundamentally right or wrong (see Figure 7).

The Student group and the Life Science group responded similarly, with approximately half of the respondents in both groups agreeing that if there is life on Mars, it should be left undisturbed. Approximately a third of the respondents in both groups agreed that it is morally wrong to bring life back to Earth from another planet. On the issue of introducing life from Earth onto another planet, approximately a third of the Student group believed



it was wrong to do so, compared with slightly over half (50.4%) of the Life Science group. Indeed, the Life Science group stood out most clearly on this matter.

However, respondents in the Planetary Society group appeared much less concerned about

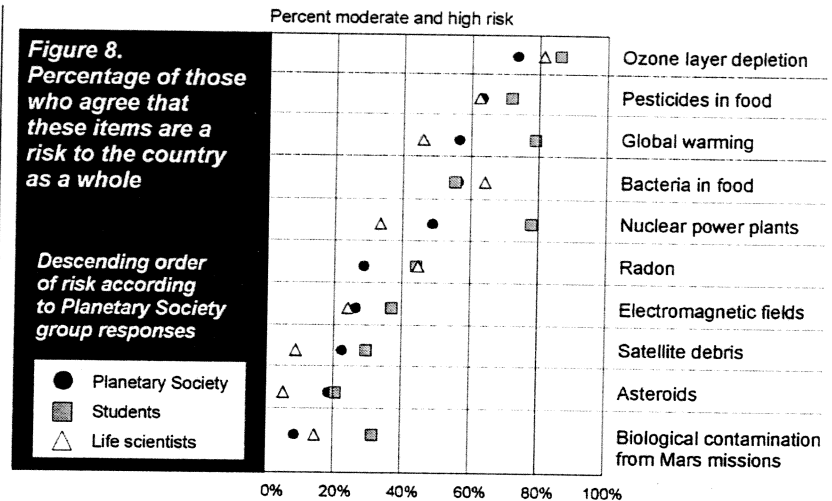
the morality of exchanging life between planets. A relatively small percentage agreed that it is morally wrong to bring life back to Earth from another planet, and only

slightly more (17.8%) agreed that it is wrong to introduce life from Earth onto another planet.

Perceptions of Planetary Protection in the Context of Societal Risks

Respondents were asked to rate a number of societal risks as a means of placing risks associated with planetary protection and exploration in a broader context (see Figure 8).

In general, the three space-related items tended to fall at the bottom of the hazard list for all three respondent groups. It appears that, at least in the



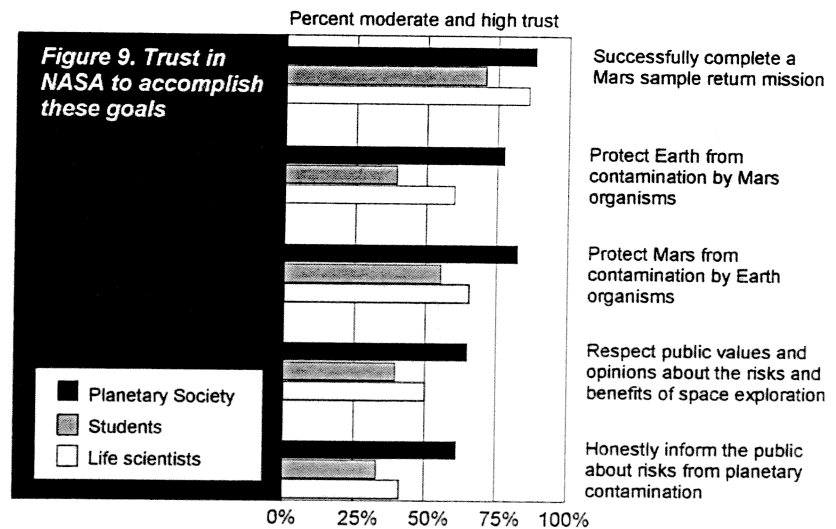
minimal context provided by the hazard items used here, biological contamination from future Mars

missions is not at this point an outstanding risk in these respondents' minds.

Trust in NASA

A powerful determinant of public perception and acceptance of risk is public trust in the organizations responsible for risk management (see Figure 9).

All three groups indicated a high degree of trust in NASA to successfully complete a Mars sample return mission, although less so for the Student group than for the other two groups. A large



majority of respondents in the Planetary Society group had a moderate or high level of trust in

NASA to accomplish planetary-protection goals. However, respondents in the Student and Life

Science groups were somewhat less trusting in this regard.

The lowest levels of trust for all three groups were with regard to risk management and risk communication. Though somewhat over half of the Planetary Society group expressed trust in NASA to respect public values and opinions about the risks and benefits of space exploration and to honestly inform the public about planetary-contamination risks, the Student and Life Science groups were less trusting. Only

about a third of the student group responded with moderate or high trust in NASA's respect for public values and opinions and honesty in risk communication.

The relative skepticism and distrust that all three surveyed groups appeared to show for NASA's abilities to deal with public issues can be looked upon as reflective of the general public distrust of government and industry in managing risk issues in society.

Environmental Group Affiliation and Perceptions of Planetary Protection

Table 1. Comparison of mean scale score values by environmental-group affiliation (Planetary Society survey group only)

Scale	No environmental-group affiliation	Non-Greenpeace affiliation	Greenpeace affiliation	F-test
BENEFIT	2.49	2.46	2.47	n.s.
THREAT	2.68	2.70	2.79	**
EXPLORE	3.27	3.24	3.15	****
MORALITY	1.82	1.86	2.07	****
LIFE	2.86	2.75	2.91	***
ECOLOGY	2.45	2.59	2.89	***
TRUST	2.79	2.82	2.62	**

**p < .01

***p < .001

****p < .0001

Respondents in the Planetary Society group were asked to indicate if they were affiliated with an environmental group and to list the group(s). Of the 3940 U.S. and Canadian respondents, 1027 (26.1%) indicated that they were affiliated with an environmental group. The number of different environmental groups named by respondents was quite extensive, and included both national and international groups, as well as local or regional groups. Over 350 different groups were named by those who indicated some environmental group affiliation.

The Planetary Society group was divided into three subgroups. The first subgroup was comprised of respondents who indicated no environmental group affiliation. The remain-

ing respondents were divided into (a) those who tended to be affiliated with environmental groups known for taking strongly activist positions on environmental issues, and (b) those who were affiliated with less activist groups. To facilitate this division, respondents who indicated an affiliation with Greenpeace were put in the more activist group. The remaining group was comprised of respondents who indicated an affiliation with one or more environmental groups, none of which was Greenpeace.

This division of respondents was then compared in terms of mean scores on each of a set of item scales developed by summing responses to categories of items all measuring the same concept (see Table 1).

Though the three groups did not differ significantly on perceived benefit of space exploration, they did differ on other dimensions.

Compared with those respondents indicating no environmental affiliation, respondents in the Greenpeace group were: more likely to view planetary contamination as a threat (THREAT), less aggressive in their approach to space exploration (EXPLORE), more concerned

about the morality of exchanging life between planets (MORALITY), more sure about life existing elsewhere (LIFE), more concerned about preserving and protecting nature (ECOLOGY), and less trusting of NASA (TRUST). It appears from these results that attitudes about space exploration and planetary protection are related to other environmental attitudes and particularly to environmental activism.

Discussion

Overall, the results of the study indicate that public perception of biological hazards associated with a Mars sample return mission is not seen as a large risk relative to other technological and environmental risks and hazards, such as nuclear technologies, food risks, and ozone depletion. However, its perceived magnitude at present may be due more to the paucity of information pertaining to such a hazard than to its inherent qualities as a risk.

In general, all of the groups surveyed, lay and expert alike, indicated that NASA should take a cautious approach in dealing with materials that pose a potential or unknown biological hazard. However, there was no indication in the results that such cautiousness should be

taken to mean that Mars sample return missions should not be conducted. Indeed, all of the groups surveyed expressed a high degree of trust and confidence in NASA to successfully conduct a sample return mission and accomplish planetary-protection goals. There was, however, some skepticism that NASA would be honest and open with regard to informing the public and considering public attitudes and values.

Further research should be undertaken to examine the basis for these and other differences that appeared in the results between the lay and expert groups, including further surveys with other expert groups, such as those who have a background in microbiology, infectious diseases, and exobiology.

Acknowledgment

This research was supported in part by the National Aeronautics and Space Administration and SETI, under subcontract #986-9601 to Decision Science Research Institute. The authors would like to thank Dr. Donald Di Vincenzi of NASA Ames Research Center for his guidance in the early stages of project development, as well as Charlene Anderson and Gloria Joyce of *The Planetary Report* for their invaluable role in editing and preparing the survey for publication. Special thanks as well to Dr. John Schwartz and Dr.

Michaela Zint of the Michigan Sea Grant Institute who were most helpful in recruiting life-science experts for the study. We would also like to thank C. K. Mertz for her thorough statistical analysis of the data, Dr. Stephen Johnson for obtaining the student sample, and Leisha Mullican for her careful attention to manuscript preparation.

To obtain the complete technical paper on which this brief report is based, please contact the first author, Dr. Donald MacGregor, at Decision Science Research Institute (Decision Research) in Eugene, Oregon.